APLAB

APLAB FREQUENCY CONVERTER

TYPE : TIS/240/500/3

instruction manual

MP MASTER

MA23207

APLAB FREQUENCY CONVERTER

TYPE : TIS/240/500/3

TECHNICAL SPECIFICATIONS :

INPUT	: 240V a.c. ±10%, 50Hz.
OUTPUT :	
VOLTAGE	: 200V a.c. 3 ø (115V phase to neutral) Adjustable through front panel control.
STABILITY OF OUTPUT VOLTAGE AGAINST SPECIFIED LINE VARIATION AND FROM NO LOAD TO FULL LOAD.	: ±2%
FREQUENCY	: 400Hz
STABILITY OF OUTPUT FREQUENCY UNDER SPECIFIED OPERATING CONDITIONS.	: Better than ±1%
PHASE ANGLE ERROR	: Less than ±1%
CAPACITY	: 166VA max. per phase for resistive loads.
LOAD POWER FACTOR	: 0.8 lagging to unity. The output capacity should be derated to 75% of rated output for a P.F. of 0.8 linearly.
WAVEFORM DISTORTION	: 5% max.
COOLING	: Forced cooled with the help of instrument cooling fan.
AMBIENT TEMPERATURE	: $0^{\circ}C - 50^{\circ}C$.
DIMENSIONS	: 19" Rack mounting 4 unit high 22" behind the panel.
NET WEIGHT	: Approx. 40 Kgs.

TECHNICAL SPECIFICATIONS :

INPUT	: 240V a.c. ±10%, 50Hz.
OUTPUT :	
VOLTAGE	: 230V a.c. 3 ϕ (115V phase to neutral) Adjustable through front panel control.
STABILITY OF OUTPUT VOLTAGE AGAINST SPECIFIED LINE VARIATION AND FROM NO LOAD TO FULL LOAD.	: ±2%
FREQUENCY	: 400Hz
STABILITY OF OUTPUT FREQUENCY UNDER SPECIFIED OPERATING CONDITIONS.	: Better than ±1%
PHASE ANGLE ERROR	: Less than ±1%
CAPACITY	: 150VA max. per phase for resistive loads.
LOAD POWER FACTOR	: 0.8 leading to unity. The output capacity should be derated to 75% of rated output for a P.F. of 0.8 linearly.
VOLTAGE DISTORTION	: 5% max.
COOLING	: Forced cooled with the help of inbuilt cooling fan.
AMBIENT TEMPERATURE	: $0^{o}C$ - $50^{o}C$.
DIMENSIONS	: 19" Rack mounting 4 units high 22" behind the panel.
NET WEIGHT	: Approx. 40 Kgs.

INTRODUCTION :

APLAB FREQUENCY CONVERTER TYPE TIS240/500/3 converts a single phase line supply of 240V a.c. 50Hz into a three phase output, whose frequency is 400Hz. This 3 phase generator provides excellent voltage and frequency stability.

The basic oscillator is a sine wave oscillator. This is amplified for higher voltage and power. Therefore the distortion is minimum. The amplifiers and transformers are carefully designed to keep the no load drain to be less than five percent of the full load current. The simplicity of the design makes it easy for maintenance.

INSTALLATION & OPERATING INSTRUCTIONS :

Initial Inspection :

Before installation check the unit for any physical damage caused during transit. Save the packing material untill the inspection is over. If damage is found, notify the carrier.

Controls, Switches & Indicators :-

1. Input :-

   This input socket is provided on the rear panel. A mains cord with 3 pin plug is supplied along with the unit for input connection.

2. Output Termination :-

   Output termination is provided through a 3 way terminal block mounted on the rear panel. The three phases (R, Y, B) and a neutral (N) terminals are clearly marked on the panel.

3. ON Input Switch, Fuse :-

   The power ON/OFF Switch is provided on the front panel thro' which the unit can be switched ON.

   The input fuse is also provided on the rear panel.

INTRODUCTION :

APLAB FREQUENCY CONVERTER TYPE TI324D/3U9/3 converts a single phase line supply of 240V a.c. 50Hz into a three phase output, whose frequency is 400Hz. This 3 phase generator provides excellent voltage and frequency stability.

The basic oscillator is a sine wave oscillator. This is amplified for higher voltage and power. Therefore the distortion is minimum. The amplifier and transformers are properly designed to keep the no load drain to be less than five percent of the full load current. The simplicity of the design makes it easy for maintenance.

INSTALLATION & OPERATING INSTRUCTIONS :

Initial Inspection :

Before installation check the unit for any physical damage caused during transit. Move the packing material until the inspection is over. If damage is found, notify the carrier.

Controls, Switches & Indicators :-

1. Input :-

This input socket is provided on the rear panel. A mains cord with 3 pin plug is supplied along with the unit for input connection.

2. Output Termination :-

Output termination is provided through a 3 way terminal block mounted on the rear panel. The three phases (R, Y, B) and a neutral (N) terminals are clearly marked on the panel.

3. On Input Switch, Fuse :-

The power ON/OFF Switch is provided on the front panel thro' which the unit can be switched ON.

The input fuse is also provided on the rear panel.

4. Output ON/OFF Switch :-

This is a three pole switch, connected in series with the three phases of the output. When it is in 'ON' position the output is available at the terminal block. This switch is actually a miniature circuit breaker which would trip off in the event of excess current in any of the phases, thus isolating the load from the output. It can be reset immediately after the removal of the over load.

5. ADJ OUTPUT VOLTS :-

The voltage of individual phases can be adjusted to 115 ±5% volts. For this a screw driver adjustment is provided on the front panel. The corresponding controls are marked as R, Y, B. Loosen the nut before adjusting the voltage and lighten it after adjustment. This will keep the set voltages constant.

6. Input Indicator Lamp :-

This lamp on the front panel of the unit indicates the presence of input when the unit is switched ON.

7. Output Indicator Lamps :-

Mounted below these controls are the three indicator lamps, which will glow when the output switch is ON. The corresponding phases of the lamps are marked.

8. Overheat Indications Lamp :-

This is an indication of excessive temperature of the heat sinks on which aremmounted the power transistors in the amplifier section. If this lamp is found glowing the reason for temperature rise should be investigaged. Over loading and fan failure are the common causes.

INSTALLATION/OPERATION :

The unit is shipped in ready to use condition. The unit should be placed in such a way that the hot air blown by the fan is not returned to the unit.

4. Output ON/OFF Switch :-

This is a three pole switch, connected in series with the three phases of the output. When it is in 'ON' position the output is available at the terminal block. This switch is actually a miniature circuit breaker which would trip off in the event of excess current in any of the phases, thus isolating the load from the output. It can be reset immediately after the removal of the over load.

5. All OUTPUT VOLTS :-

The voltage of individual phase can be adjusted to 115 ±5% volts. For this a screw driver adjustment is provided on the front panel. The corresponding controls are marked as R, Y, B. Loosen the nut before adjusting the voltage and tighten it after adjustment. This will keep the set voltages constant.

6. Input Indicator Lamp :-

This lamp on the front panel of the unit indicates the presence of input when the unit is switched ON.

7. Output Indicator Lamps :-

Mounted below three contacts are the three indicator lamps, which will glow when the output switch is ON. The corresponding phases of the lamps are marked.

8. Overheat Indication Lamp :-

This is an indication of excessive temperature of the heat sinks on which transmounted the power transistors in the amplifier section. If this lamp is found glowing the reason for temperature rise should be investigated. Over loading and fan failure are the common causes.

INSTALLATION/OPERATION :

The unit is shipped in ready to use condition. The unit should be placed in such a way that the hot air blown by the fan is not restored to the unit.

Keep both the switches in OFF position initially. Plug the unit to the suitable commercial supply line. Turn the POWER ON/OFF Switch ON. The neon below this switch will glow, indicating that the unit is on. When the output switch(3 pole MCB) is turned ON, the 3 phase output will be available at the output termination. Measure it with a voltmeter, first between neutral and the R,Y,B phase points individually and adjust it to 115V thro' individual controls. The measure the voltages between the phases, which should be 198V. This ensures that the phase shifts are proper. Now the actual load can be connected. The voltage will drop by about 2 volts. If necessary, the voltages can be set back to 115V precisely on load.

THEORY OF OPERATION :

The Frequency Converter basically consists of three independent inverters, each complete with a 400Hz oscillator. Each inverter generates a 115V, 400Hz output and the three outputs are 120° phase shifted from each other. The low ends of these outputs are shorted together and brought out as Neutral, while the three high ends act as R, Y, B phases. This provides a three phase star connected output. The different stages of this converter are described below.

POWER SUPPLY UNIT (PSU) : (Ref.to Ckt.dia.no.284A5)

This is a pre-regulated type d.c. power supply which generates 48V, the load and line regulation of which is about $\pm 2.5\%$.

The incoming line input is fed to primary of step down transformer T1 through a triac TR1. The voltage available at secondary is rectified and filtered using a diodes bridge and a capacitor bank C9. This d.c. voltage is maintained at 48V by controlling the conduction angle of triac TR1. This is achieved by manipulating the firing pulses i.e. either advancing or delaying them, to the triac, a job done by the control circuitry.

This control circuitry consists of -

a) a step down transformer T2, the rectified secondary voltage of which is used as line sample. This is fed to get of Q6 - a programmable UJT. This basically takes care of the line regulation and

b) an error amplifier which senses the d.c. voltage (40V) and adjusts it continuously by controlling the firing pulse, in each half cycle.

The correction is applied in each half cycle. As said earlier, the gate of Q6 is returned to junction of R4 & R5 where as full wave rectified replies of input voltage is available. The anode of Q6 connected to +ve of C7. Whenever the anode voltage exceeds gate voltage, Q6 conducts and discharge C7. A pulse is given to the triac TR1 at this time which starts conducting and continues to do so in that half cycle. The instant at which this happens is decided by (i) The rate at which C7 is charged (ii) the amplitude available at gate of Q6. If the line voltage goes down, then this amplitude is also low and for a given. rate of charging of C7, Q6 will conduct earlier, thus TR1 will have larger conduction angle, maintaining the secondary voltage at fixed level. Thus line regulation is taken care of.

If the d.c. voltage goes low for any reasons (for example with load) Q3 is less forward biased, thus Q4 conducts more, which in turn makes Q5 conduct more. Thus C7 is charged faster, and therefore the anode potential reaches the gate voltage earlier. This results into larger conduction angle of triac and consequential higher d.c. voltage. This is how the load regulation is achieved.

Q2 discharges C7 at every zero crossing, thus at the begining of every half cycle, it is fully discharged, and is ready to charge up at a rate decided by the d.c. output voltage level.

This regulated d.c. supply is used by inverter circuitry for its operation.

INVERTER : (Ref.Ckt.dia.no.286A5)

1. Sine Wave Oscillator :-

The integrated circuit IC1 form a sine wave oscillator which provides a 400Hz sinusoidal output when the frequency determining components R5 and C2 are selected for this.

2. Boosted Driver Amplifier :-

After the signal is sufficiently amplified with a step-up transformer, it is fed to the driver stage. This stage provides adequate current drive to

the final power stage i.e. output amplifier. A special patented booster circuitry, consisting of CR10, CR11 and C18 ensures that the collectors of the driver transistors Q6 to Q9 are held about 5 to 6 volts. Above the supply voltages. This ensures a linear operation of the driver resulting in higher overall efficiency without adding to the waveform distortion by way of clipping, especially at low supply voltages.

3. Push-pull Amplifier (Output Stage). :-

The output amplifier is a push-pull stage, working in grounded collector configuration. (Transistors Q10, Q11). Depending upon the power requirement, number of devices are paralleled together. The devices are properly matched for their betas to ensure that the current is shared equally by all the devices connected in parallel.

The desired output voltage is obtained with a suitably designed output transformer (T2). The primary of such a transformer is bifilar-wound to keep the no-load drain to minimum.

4. Control Circuitry :-

The voltage gain of the amplifier, made up of transistors Q1 to Q5 and the associated circuitry is controlled by a series voltage feedback to stabilize the output voltage. This feedback, proportional to the output voltage is achieved by means of -

a) a lamp photo-resistor module MCL703C, transistors Q14 which drives the lamp in this module, and a differential amplifier, made-up of transistors Q15 & Q16 which biases Q14 more or less depending upon whether the output has gone higher or lower. The sensing signal proportional to the output is obtained with transformer T3 and CR17, CR18 etc., which is applied to the base of Q16.

b) The photo-resistor part of this module, connected across the amplifier the value of which varies with the light incident upon it. With increasing current through the lamp the R of MCL703C reduces, thus reducing the input swing to the primary of driver transformer. An excellent stabilization of output voltage is thus obtained.

5. Surge Protection Circuit :-

Transistors Q12 & Q13 and the associated components form a surge-protection circuit. This prevents the inverter from taking a high initial surge,which may result in failure of power transistors. This protection circuit lowers the gain of the amplifier mentioned above considerably till the oscillator is well stabilized, and then allows the amplifier amplitude to build-up slowly. It also prevents the output of the inverter from going high momentarily when the inverter is switched on.

GUARANTEE :

APLAB FREQUENCY CONVERTER TYPE TIS240/500/3 is exhaustively tested before despatch. In the event of failure during one calendar year from the date of receipt by the customer, the Instrument will be repaired free of charge provided that it has been used within its mechanical, electrical & environmental ratings and it is returned to our works carriage paid. No responsibility can be accepted for any consequential damage.

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COMPONENT SCHEDULE FOR PSU

RESISTORS : (All resistors are 1/8W, 5% unless otherwise specified).

R1	4.7 K
R2 & R3	3.3 K
R4	20 K
R5 & R6	10 K
R7	1 K
R8	15 K
R9	39 K
R10	7.5 K
R11 & R12	3.3 K
R13	10 K
R14	1.5 K
R15	82 K
R16	7.5 K
R17	680 ohms
R18	10 ohms
R19	470 ohms

CAPACITORS :

C1	47 mfd	50 V	Electrolytic
C2	1 K pf		Pin-up type Ceramic
C3	100 mfd	50 V	Electrolytic
C4	1 K pf		Polyester
C5	0.1 mfd	250 V	Metal Polyester
C6	10 mfd	40 V	Electrolytic
C7	2 mfd	64 V	Electrolytic
C8	0.05 mfd	1000 V	Metal Polyester
C9	24x4700 mfd	63 V	Electrolytic

DIODES :

CR1 to CR3	1N4003
CR4 & CR5	CD21
CR6 & CR7	1N4003
CR8 to CR11	D100M 200A D100 200C

TRANSISTORS :

Q1 to Q4 (in single IC)	IC3086
Q5	BC177
Q6	PUT 2N6027

INTEGRATED CIRCUIT :

IC1	uA723

TRIAC :

TR1	T6420M

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COMPONENT SCHEDULE FOR INVERTER

(Ref. Drg. No. 286A5)

RESISTORS : (All resistors are 1/8W, 5% unless otherwise specified)

R1 & R2	10	K	
R3	27	K	
R4	18	K	
R4a	220	K	
R5	Selected		
R6 & R7	10	K	
R8	180	ohms	
R9	10	K	
R10	470	ohms	½W
R11 & R12	10	K	
R13 & R14	470	K	
R15 & R16	10	K	
R17	100	K	
R18	1	K	
R19	10	K	
R20	4.7	K	
R21	1	K	
R22	3.9	K	
R23	18	K	
R24	390	ohms	
R25	100	ohms	
R26	680	ohms	
R27	100	ohms	
R28	680	ohms	
R29 & R30	4.7	ohms	
R31	100	K	
R32	5.6	K	
R33	1	K	Car.Lin.Preset
R34 & R35	47	ohms	
R36 & R37	68	ohms	½W
R38 & R39	.05	ohms	2.5W
R40 & R41	15	ohms	½W

R42 & R43	0.05	ohms	2.5W
R44	10	ohms	1W
R45	2.2	K	
R46	4.7	K	
R47	1	K	
R48	2.2	K	
R49	12	K	
R50	1	K	
R51	3.9	K	
R52	150	ohms	
R53	1	K	
R54	470	ohms	
R55	1	K	
R56	12	K	
R57	2	K	W/W Pot (ADJ 115V Control)
R58	Selected		(18K // High Value Resistor)

CAPACITORS :

C1	10	mfd	35 V	Tantalum
C2	.033	mfd	250 V	Metal Polyester
C3 to C6	10	mfd	35 V	Tantalum
C7 & C8	1	mfd	35 V	Tantalum
C9	10	mfd	16 V	Electrolytic
C10	32	mfd	10 V	Electrolytic
C11	47	pf		Ceramic
C12	125	mfd	16 V	
C13	250	mfd	50 V	
C14	50	mfd	25 V	
C15	0.1	mfd	250 V	Metal Polyester
C16	4700	pf	160 V	Polyester
C17	1	mfd	250 V	Metal Polyester
C18	1000	mfd	25 V	Electrolytic
C20	50	mfd	25 V	Electrolytic
C21	250	mfd	50 V	Electrolytic
C22	47	pf		Ceramic
C23	.1	mfd	250 V	Metal Polyester

DIODES :		JEDEC EQUIVALENT
CR1 to CR7	CD21	1N4003
CR8 & CR9	BY126	1N4003
CR10 to CR18	1N4003	

ZENERS :		
Z1	CZ5	1N751A
Z2	CZ9	1N757A
Z3	CZ5	1N751A
Z4 & Z5	2N869	
Z6	CZ9	1N757A
Z7	CZ5	1N751A

TRANSISTORS :		
Q1 & Q2	BC107A	
Q3	2N2904A	
Q4 & Q5	2N3053	
Q6 & Q7	2N3499	
Q8 & Q9	2N3442	
Q10 & Q11	2N6259	(5 in parallel)
Q12	2N3053	
Q13	BC177A	
Q14	2N2904A	
Q15 & Q16	BC107A	

INTEGRATED CIRCUITS :	
IC1	Function Generator IC
IC4	78MGU

PHOTO CELL LAMP : MCL703C

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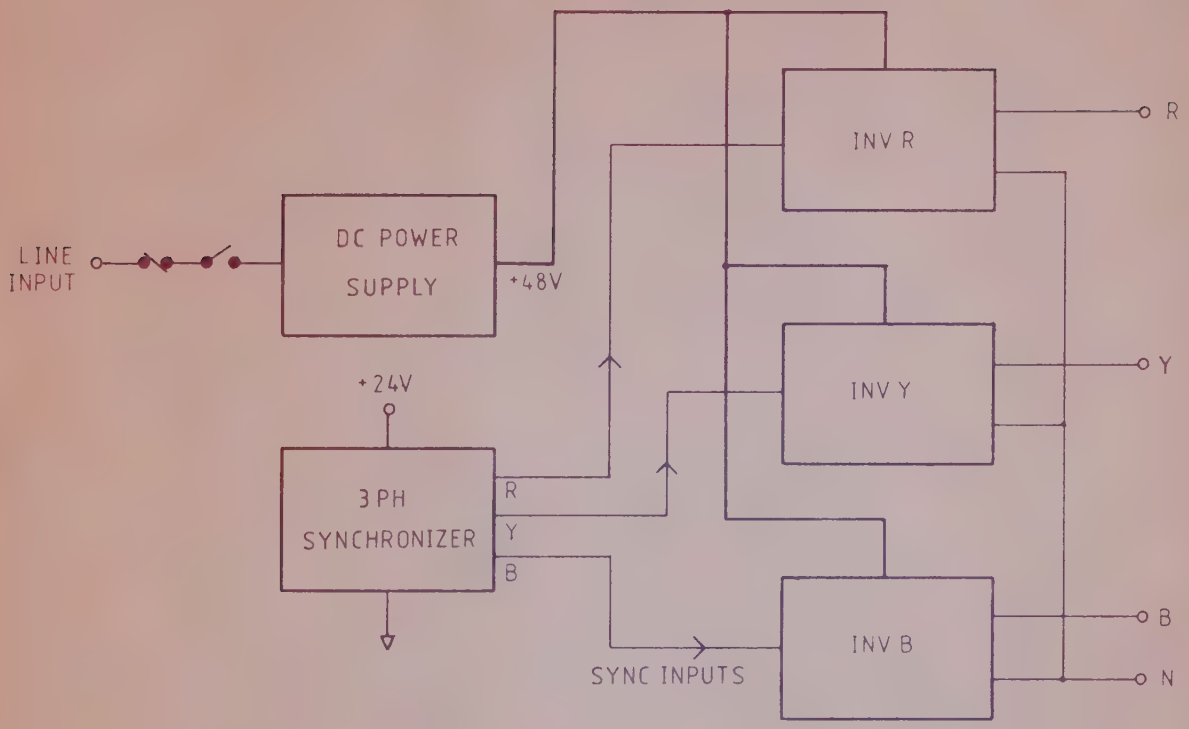

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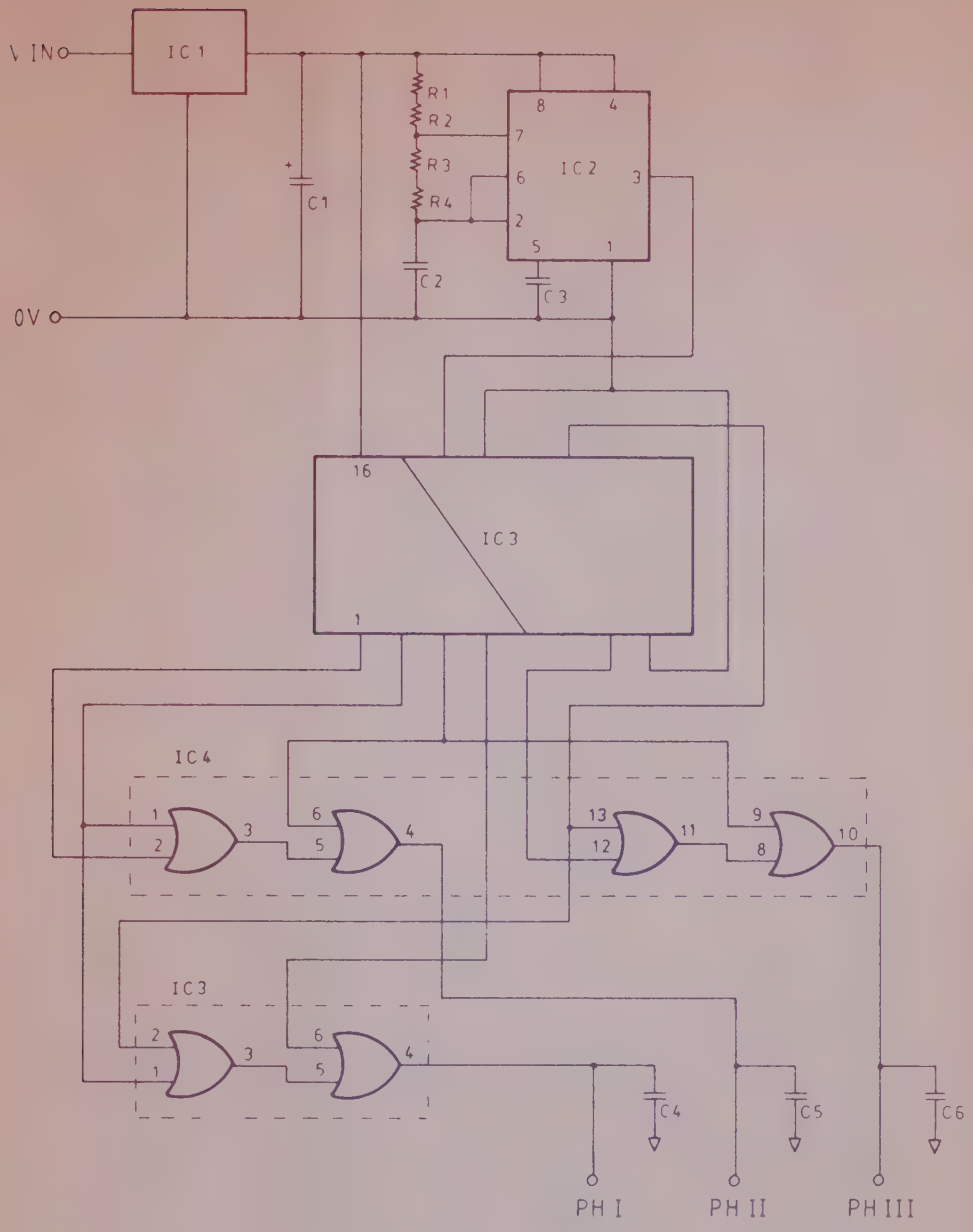
FREQUENCY CONVERTER
SCHEMATIC DIAGRAM

TYPE:TIS 240/

DRG.NO:251A5

DRN.BY.DILIP NAIK. DATE:-31-07-81



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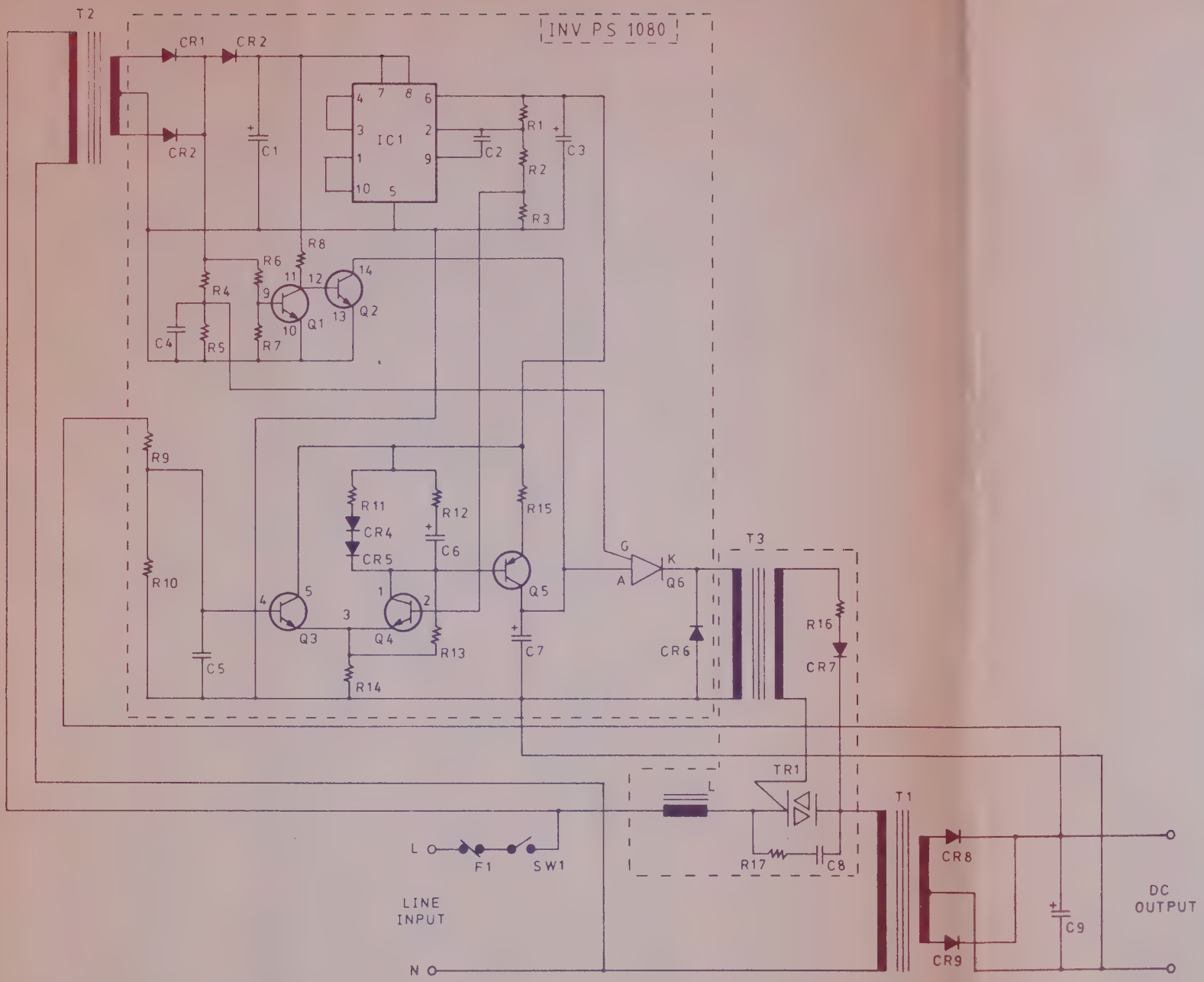
3 PHASE SYNCHRONISER

MODEL :

DRG.NO: 275A5

DRN.BY. DILIP NAIK. DATE :- 16-01-83



Q1 TO Q4 ARE IN A SINGLE IC 3086

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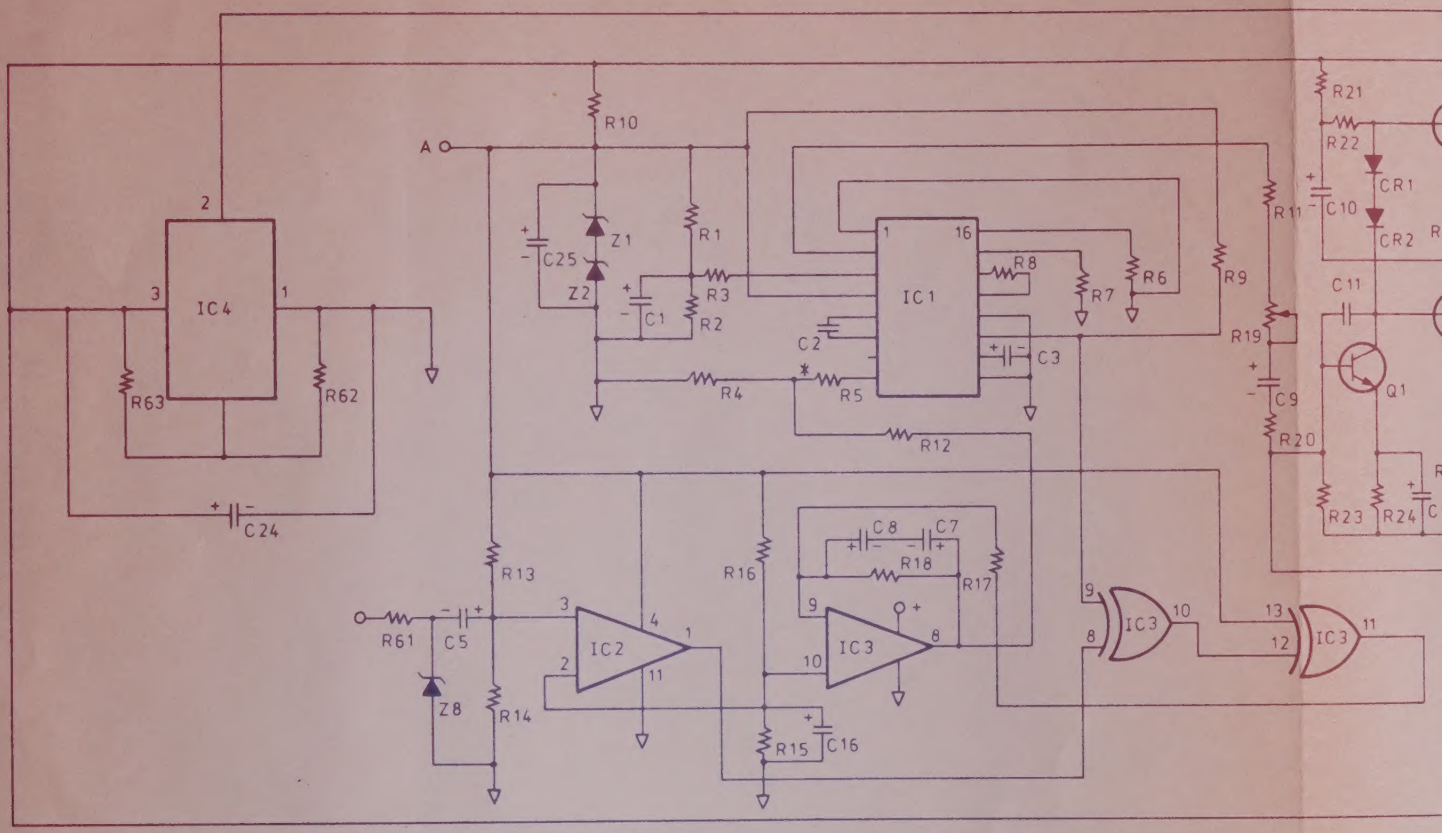
PREREGULATED POWER SUPPLY

TYPE/MODEL

DRG.NO : 284A5

DRN. BY. DILIP NAIK. DATE:- 12-06-83



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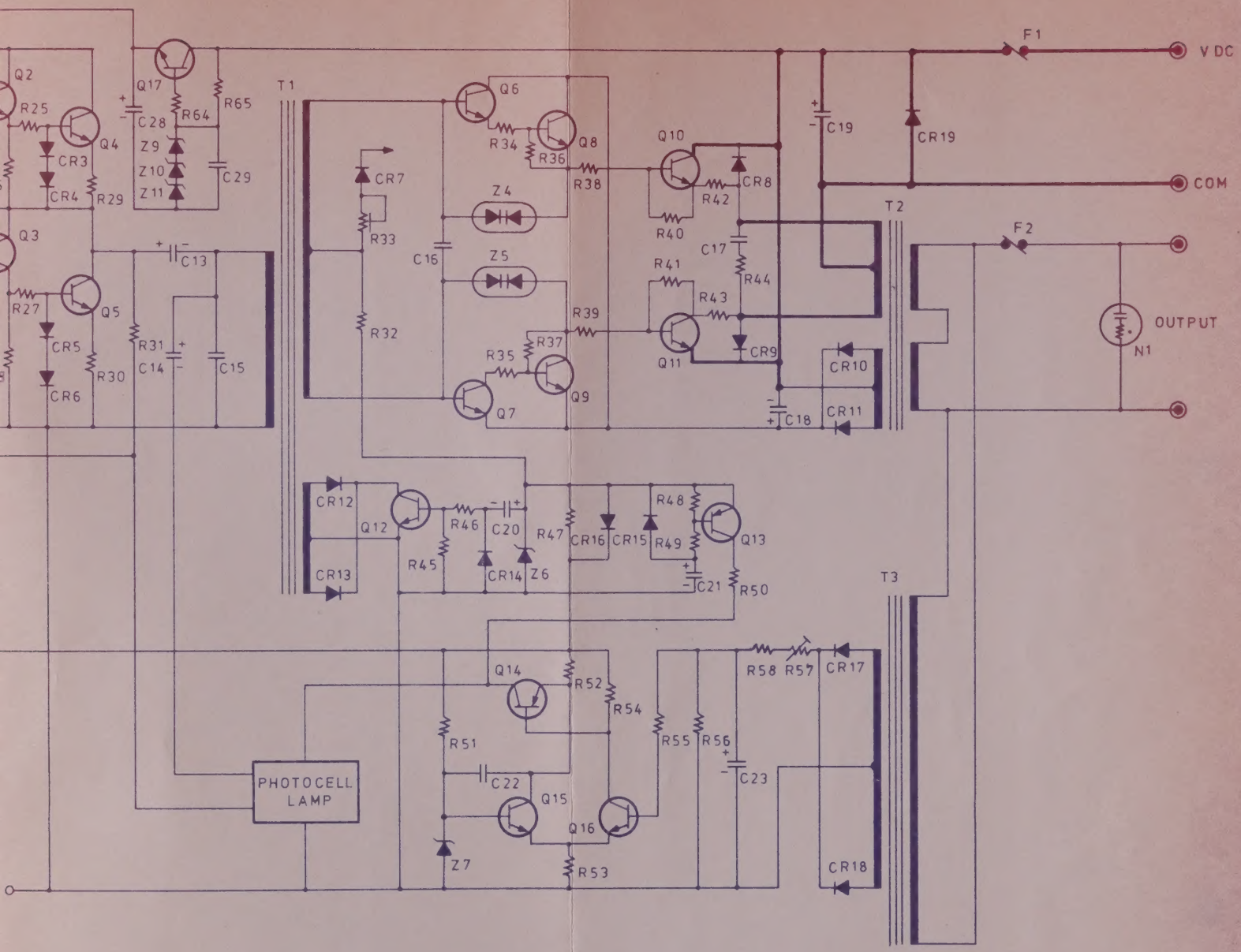

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SINE WAVE INVERTER

TYPE/MODEL

DRG. NO: 286A5

DRN. BY. DILIP NAIK DATE:-11 - 07 - 83

MP MASTER
MA23207